CBCS SCHEME

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15ME63

Sixth Semester B.E. Degree Examination, June/July 2018
Heat Transfer

Time: 3 hrs. Max. Marks: 80

Note: 1. Answer any FIVE full questions, choosing one full question from each module.
2. Use of Heat transfer data hand book, steam table are permitted.

Module-1

1 a. What do you mean by boundary condition of 1st, 2nd and 3rd kind? **(06 Marks)**

b. Explain briefly the mechanism of conduction, convection and radiation of heat transfer. **(06 Marks)**

c. A mild steel tank of wall thickness 20 mm is used to store water at 95°C. Thermal conductivity of mild steel is 45 W/m °C, and the heat transfer coefficient inside and outside the tank are 2850 W/m^2 °C and 10 W/m^2 °C respectively. If surrounding air temperature 20°C, calculate Rate of heat transfer per unit area of the tank. **(04 Marks)**

OR

2 a. Derive the general three dimensional heat conduction equation in Cartesian coordinate and state the assumption made. **(08 Marks)**

b. The wall of a house in cold region consists of three layers, an outer brick work 15 cm thick, the inner wooden panel 1.2 cm thick, the intermediate layer is insulator of 7 cm thick. The 'k' for brick and wood are 0.7 and 0.18 W/mK. The inside and outside temperature of wall are 21 and – 15°C. If insulation layer offer twice the thermal resistance of the brick wall, calculate (i) heat loss per unit area (ii) 'k' of insulator. **(08 Marks)**

Module-2

3 a. Derive the expression for critical thickness of insulation for cylinder. **(06 Marks)**

b. Differentiate between effectiveness and efficiency of fins. **(04 Marks)**

c. A rod [k = 200 W/mK] 5 mm in diameter and 5 cm long has its one end maintained at 100°C. The surface of the rod is exposed to ambient air at 25°C with convection heat transfer coefficient of 100 W/m^{2}K. Assuming other end is insulated. Determine (i) the temperature of rod at 20 mm distance from the end at 100°C (ii) Heat dissipation rate from the surface of rod (iii) Effectiveness. **(06 Marks)**

OR

4 a. Derive the expression for temperature variation and heat flow using Lumped Parameter Analysis. **(06 Marks)**

b. Explain significance of Biot and Fourier number. **(04 Marks)**

c. The average heat transfer coefficient for flow of 100°C air over a flat plate is measured by observing the temperature time history of a 3 cm thick copper slab exposed to 100°C air, in one test run, the initial temperature of slab was 210°C and in 5 min the temperature is decreased by 40°C. Calculate the heat coefficient for this case. Assume ρ = 9000 kg/m^3 ; C = 0.38 kJ/kgK , K = 370 W/mK. **(06 Marks)**

Module-3

5 a. Explain formulation of differential equation 1-D steady heat conduction. **(06 Marks)**

b. Explain different solution method used in numerical analysis of heat conduction. **(06 Marks)**

c. Explain applications and computation error of numerical analysis heat conduction. **(04 Marks)**

OR

6 a. Define (i) Blackbody (ii) Planks law (iii) Wein displacement law (iv) Lamberts law. **(06 Marks)**

b. Prove that emissive power of the black body in hemispherical enclosures in π terms o intensity of radiation. **(06 Marks)**

c. The temperature of black surface of 0.2 m^2 area is 540°C. calculate (i) the total rate o energy emission (ii) the intensity of normal radiation (iii) the wavelength of maximun monochromatic emission power. **(04 Marks)**

Module-4

7 a. Explain with neat sketches (i) Velocity Boundary layer (ii) Thermal boundary layer. **(08 Marks)**

b. Air flows over a flat plate at 30°C, 0.4m wide and 0.75m long with a velocity of 20m/s Determine the heat transfer from the surface of plate assuming plate is maintained at 90°C Use $N_{UL} = 0.664\ R_e^{0.5}\ Pr^{0.33}$ for laminar

$N_{UL} = \left[0.036\ R_e^{0.8} - 0.836\right] Pr^{0.333}$ for turbulent. **(08 Marks)**

OR

8 a. Explain the physical significance of the following dimensionless number: (i) Reynold's number (ii) Prandtl number (iii) Nusselt number (iv) Stantor number. **(06 Marks)**

b. A stream pipe 5 cm in diameter is lagged with insulating material of 2.5 cm thick. Th surface temperature is 80°C and emissivity of the insulating material surface is 0.93. Fin the total heat loss by natural convection and radiation. The temperature of the ai surrounding the pipe is 20°C. Also find the overall heat transfer coefficient. **(10 Marks)**

Module-5

9 a. Derive expression for LMTD for parallel flow heat exchanger and state the assumptio made. **(08 Marks)**

b. Water enters a counter flow heat exchanger at 15°C flowing at a rate of 1300 kg/h. It i heated by oil [c_p = 2000 J/kgK] flowing at the rate of 550 kg/h with an inlet temperature o 94°C for an area 1 m^2 and overall heat transfer coefficient of 1075 W/m^2K. Determine th total heat transfer and outlet temperature of water and oil. **(08 Marks)**

OR

10 a. Explain different regimes of pool boiling with neat sketches. **(08 Marks)**

b. Draw saturated stream at a pressure of 2.0 bar condenses on the surface of vertical tube o height 1 m. The tube surface is kept at 117°C. Estimate the thickness of the condensate filn and heat transfer coefficient at a distance of 0.2 m from the upper end of the tube. Assum the condensate film to be laminar. Also calculate the average heat transfer coefficient ove the entire length of the tube. **(08 Marks)**

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